

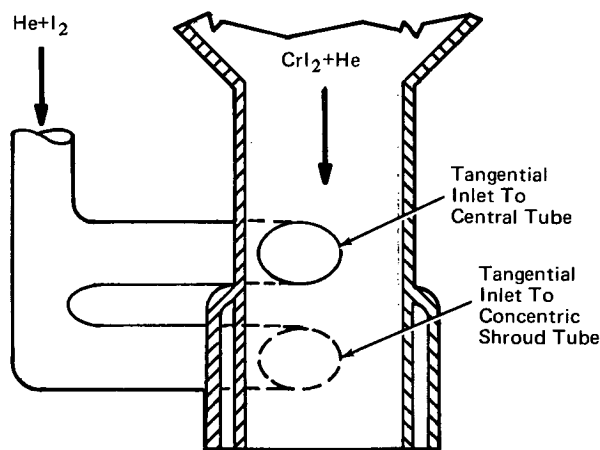
NASA TECH BRIEF

Lewis Research Center



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Dispersion-Strengthened Chromium Alloy



Nozzle Design Used To Inject the CrI_2 -Helium Mixture Into The Hydrogen-Filled Reaction Zone

The problem:

To develop a dispersion-strengthened chromium alloy that has high strength and oxidation resistance at elevated temperatures, but also has improved ductility at low temperatures.

The solution:

Consolidation of a finely divided powder mixture produced by the chemical vapor deposition of chromium on small ThO_2 particles.

How it's done:

Chromous iodide vapor is reduced with hydrogen to give a finely divided chromium powder. Entrainment of finely divided ThO_2 in the hydrogen yields an intimate mixture of chromium and thoria which is amenable to consolidation as a dispersion-strengthened body. Chromous iodide vapor (CrI_2), about 2.5 mole percent in a helium carrier gas, is fed downward into a tubular reaction chamber at 1000°C where it meets a counter-current of hydrogen gas. The gases react as $\text{CrI}_2(\text{g}) + \text{H}_2(\text{g}) = \text{Cr}(\text{s}) + 2\text{HI}(\text{g})$ to produce a finely divided high-

purity chromium powder (0.1μ to 0.4μ). When finely divided ThO_2 is entrained in the hydrogen (in amounts approximately 2-5 volume percent of the chromium), a product is obtained in which the chromium and thoria are intimately associated and which can be hot pressed or pressure bonded to give a chromium body with a fine dispersion of ThO_2 .

Tensile tests showed that the ThO_2 particles lowered the ductile-to-brittle transition temperature (DBTT) below that of pure chromium. This was evident both in the as-rolled condition and after the materials had been annealed for one hour at 1200°C . The DBTT values were:

Material	As-Rolled	Annealed
Pure Chromium	140°C	140°C
Cr- ThO_2 Alloy	15°C	50°C

Both the thermal dissociation of the chromous iodide and the hydrogen reduction reactions (which occur at about 1000°C) must be taken into account in the design of a nozzle to inject a CrI_2 -He gaseous mixture into a hydrogen-filled chamber. In a successful nozzle design (see the figure), the CrI_2 -He was forced through a centrally located tube at high gas velocities (up to 110 m/sec), while a helium-0.25 mole % iodine shroud gas was injected tangentially through both the centrally located tubular nozzle and the concentric outer shroud tube. The iodine was added to the helium to prevent the thermal decomposition of CrI_2 by dilution with the shroud gas. The design permitted use of sufficiently high gas-flow rates through the nozzle to prevent the back diffusion of hydrogen that could cause reduction of CrI_2 to metal at the nozzle opening (causing the formation of a chromium plug) without adversely affecting the subsequent mixing of the reactants in the hydrogen-filled reaction chamber.

(continued overleaf)

Notes:

1. Success in the preparation of chromium powder by this technique suggests that it can be extended to the preparation of other powdered metals, e.g., iron, nickel, cobalt, niobium, tantalum, tungsten, and molybdenum. A number of possible gas-phase reactions can be suggested for each of these metals.
2. The design of the nozzle for injection of CrI_2 -He mixtures into hydrogen should be applicable to other metal-halide reduction processes. The tangential injection of gas within the nozzle enhances mixing of the gaseous reactants.
3. The following documentation may be obtained from:
National Technical Information Service
Springfield, Virginia 22151

Reference: NASA CR-72404 (N68-34022),
Chemical Vapor Deposition of Chromium on ThO_2
Single document price \$6.00
(or microfiche \$0.95)

Reference: NASA CR-72901 (N71-35580),
Development of a Chromium-Thoria Alloy
Single document price \$3.00
(or microfiche \$0.95)

4. Technical questions may be directed to:
Technology Utilization Officer
Lewis Research Center
21000 Brookpark Road
Cleveland, Ohio 44135
Reference: B72-10378

Patent status:

No patent action is contemplated by NASA.

Source: Neil D. Veigel and J. M. Blocker, Jr. of
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